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An Assessment of Flood Hazard Causes for Efficient Flood plain Management: A Case of Neelum-Jhelum Valley, Muzaffarabad, A.J.K.

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Abstract:

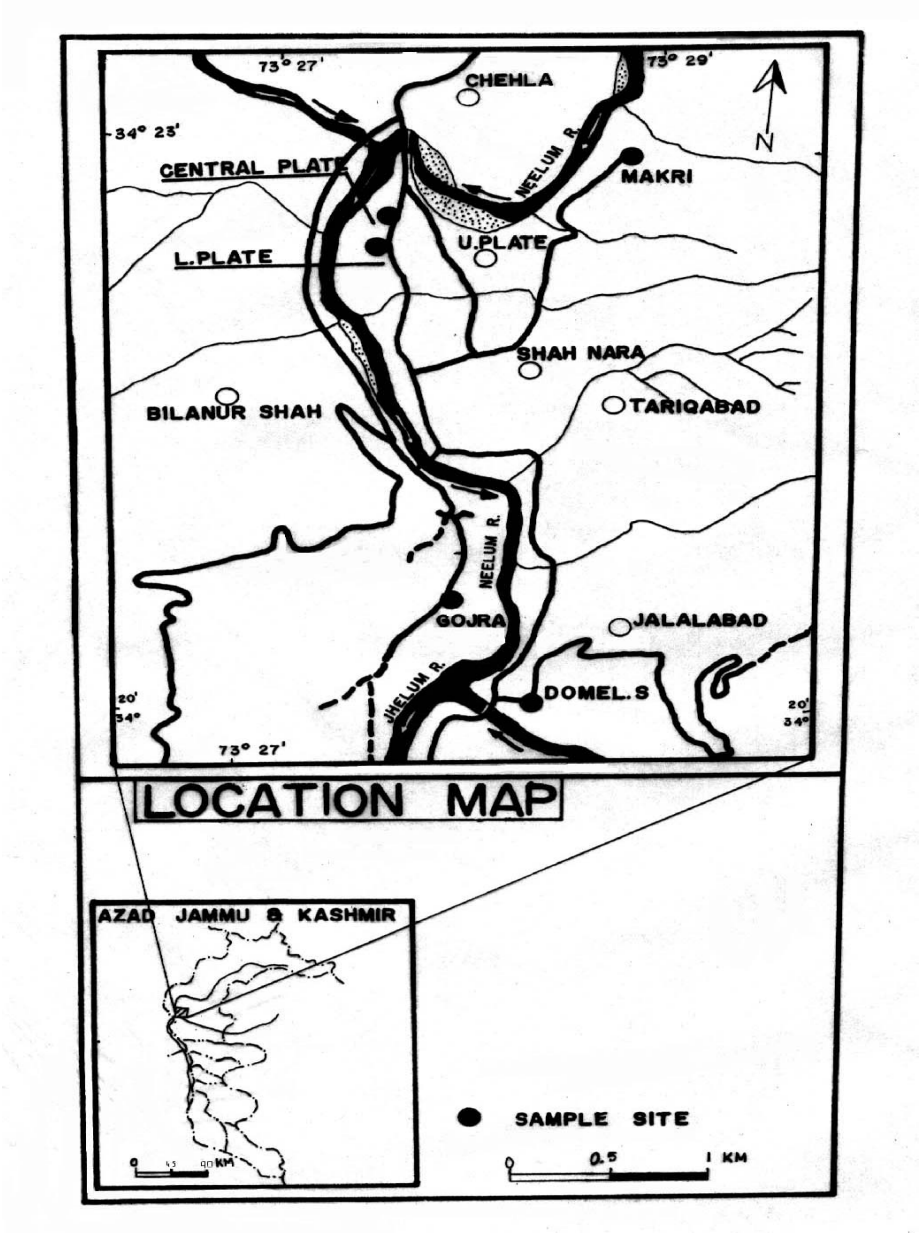
This paper attempts to analyses the causes of flood hazard in the Neelum-Jhelum valley, Muzaffarabad, Azad Jammu and Kashmir. In the study area, flood hazard is a recurrent phenomenon. In the study area, major causes of floods are the torrential rainfall and heavy melting of snow, ice and glaciers in the upper catchment area of both Neelum and Jhelum rivers. Beside these, there are some intensifying factors such as encroachment over the channel limits and lack of flood abatement measures in the upper catchment area. During summer season the discharge increases and in effect the excess water overflow the natural levees and causes great damages to life and property of the area. Therefore, this study attempts to find out the major causes of flood hazard and suggest policy recommendations for ameliorating its adverse consequences.

Introduction

Water is one of the great blessings of Allah, but sometimes excess of water causes loss of lives as well as damages to rural and urban properties. In the history of Pakistan the devastated floods in 1955, 1959, 1973, 1976, 1988, 1992, 1996, and 1997 and in 2001, caused heavy damages to housing, standing crops, irrigation network, lives and other property. Like other rivers, Neelum and Jhelum also receive heavy floods in summer season. As a result it incur heavy losses. For detailed and intensive study, five sample areas were selected in the surrounding of Muzafferabad. The sample areas include Makri, Central Plate, Lower Plate, Gojra and Domel Syedan.

Muzafferabad, is situated at the confluence of Neelum & Jhelum rivers. Both these rivers take their rise in the Himalayas mountains in occupied Kashmir. These rivers have recorded many floods during the historic time. During this century floods occurred in the two rivers during 1996, 1988 & 1958. But the flood of 1992 exceeded all the previous records. So far as the damages to economy is concerned, the flood was so severe that it brought economy to a stand still in Azad Jammu and Kashmir.

This paper attempts to analyse the causes of flood hazard in the Neelum-Jhelum valley, Muzaffarabad, Azad Jammu and Kashmir (Map 1). In the study area, flood hazard is a recurrent phenomenon. The major causes of flood hazard in the study area are the torrential rainfall and heavy melting of snow, ice and glaciers in the upper catchment area of both Neelum and Jhelum rivers. Largely, its catchment area lies in the occupied Jammu and Kashmir. Beside these, there are some intensifying factors such as encroachment over the low laying areas and deforestation in the upper catchment area. During summer season the discharge increases and in effect the excess water overflow the natural levees and causes great damages to life and property of the area. Therefore, this study attempts to find out the major causes of flood hazard and suggest policy recommendations for ameliorating its adverse consequences.


73° 27'
CHEHLA
73° 29'
34° 25'
N
CENTRAL PLATE
NEELUM R.
MAKRI
U.PLATE
L.PLATE
SHAH NARA
BILANUR SHAH
TARIQABAD
NEELUM R.
GOJRA
JALALABAD
JHELUM R.
DOMEL.S
20'
34°
73° 27'
LOCATION MAP
AZAD JAMMU & KASHMIR
SAMPLE SITE
0.5
1 KM

The Study Area

Muzaffarabad is the capital of Azad Jammu and Kashmir. Raja Muzaffar Khan (founder of the Bamba dynasty) founded the town of Muzafferabad, just on the confluence of Jhelum and Neelum rivers during the Middle of 17th century. Muzaffarabad became the capital of local Bamba dynasty, which ruled the area, till the occupation of Jammu and Kashmir, by Raja Gulab Singh. The territory remained under Dogra administration till October 22, 1947, when strong agitation rose against the Dogra tyranny (GoP, 99). Muzaffarabad Tehsil, Neelum valley, a portion of Uri Tehsil & certain parts of Karnbah areas, were liberated that constitutes the district of Muzafferabad incorporated in the Azad Jammu & Kashmir state, uptill the end of October, 1947.

Muzafferabad district with a population of 7,24,420 (1998) is bounded on the north by Diamir district of Northern Areas, in the east by the occupied state of Jammu & Kashmir, whereas in the south by Poonch district of AJK and on the west by Abbottabad & Mansehra districts of NWFP. Geographically, the area is stretches between 34^0 17' to 34^0 35' north latitude and 73^0 23' to 73^0 46' East longitude. Topographically, the entire, Muzafferabad district is mountainous & can be classified as lesser Himalayas. The Pir Panjal, is the main range whereas the two prominent glaciers are Shonthar & Sharwal. The mountains are mostly covered with coniferous trees, which is the main source of timber. However, different types of herbs are also found especially of medicinal value.

Methodology

To achieve the purpose of the study following objectives were adopted: Primarily, to examine the causes of floods in the study area. Secondly, to find out the relationship between dynamic causes and human factors responsible for floods. Finally, to suggest policy recommendations.

To achieve the objectives of the study, five sample sites were selected randomly, namely: Makri, Central Plate, Lower Plate, Gojra, and Domel Syedan. To get the required information, an intensive study was carried out. Data were gathered from both primary and secondary sources.

Primary data were collected through questionnaire survey, interview and general observation. The primary source was considered as the most appropriate tool for the collection of necessary data. Ideally, the entire populations should have been surveyed, however, given time and resources available, it was only possible to conduct sample household survey. For collection of primary data, three types of questionnaires were used: questionnaire for the whole village; questionnaire for the individual household and questionnaire for the concerned line agencies.

Whole village questionnaires were filled from the general public, community leaders, educationist and elderly people. While Individual household questionnaires having 58-fifty eight questions were filled from 10% of the total household. The sample of the respondents selected for interview is fairly diversified and heterogeneous in its composition. As far as the Questionnaire for flood dealing line agencies are concerned, it was filled from the officials of the Forest Department, Revenue Department, Deputy Commissioner, Muzafferabad Development Authority, Building Department, Public Works Department, Public Health Engineering Department, Meteorology Department etc.

Secondary data was obtained from the reports, documents, books, and research articles of the concerned departments. Finally, the collected information were classified, analysed and presented in the form of tables, maps and description.

An Overview Of Natural Hazard

The term hazard has been defined as "An interaction of people and nature, governed by the co-existent state of adjustment in the human use system and the state of nature in the natural events system (White, 1974). The concept of Natural hazard is defined by many researchers in different ways such as Burton and Kates, 1977; White, 1974; Burton, et al, 1978; Crozier, 1982. Despite variation in their point of view most of the authorities agreed that "Natural hazards are dangers brought about by a degree of exposure to geophysical or extreme natural events for which the individual or society is not prepared within the normal pattern of life". In short a natural hazard can be defined as *"a natural event, which has an adverse effect on human life".*

Flood is the most dramatic interaction between man and his environment, emphasizing both the sheer force of natural events and man's inadequate efforts to control them. Although, man has been responding to floods since long before, the days of Hazrat Noah (A.S). It is probably most widely experienced hazard.

Floods are increasing very rapidly as compare to other types of natural hazards. They are treated as physical & socio-economic phenomena, which in turn affect man's activities (Khan, 94). From time to time rivers overflow their banks, causing disasters involving loss of life & destruction of property in their wake hardships, suffering, disease & famine etc. Flood can be defined as "Body of water, which rises to over-flow land, which is not normally submerged" (Ward, 1978).

River floods are caused by both physical and human factors e.g. rainfall, when there is rainfall over the catchment area, it causes flood. Some times melting of snow also causes floods, while most often both rainfall and snow, ice and glacier jointly contribute for causing river floods. Whereas flash floods have rapid speed of onset. They are very dangerous and occur mainly due to thunderstorms and torrential rainfall. The peaked discharge received within the six hours, because of nearly small catchment area (White, 74). The main factor for this type of flood is steepness of the slope, and is very common in seasonal channels and torrents. As far as coastal floods are concerned, these are associated with cyclones & high tides. They are very catastrophic & destructive. Such floods affect most of the world's coastal areas. Sometime, earthquakes, landslides and volcanic eruptions in the oceans and seas also cause flooding in the coastal areas. They are known as tsunamis (Smith, 1979).

General Causes of Flood Hazard

5.1 Physical Causes

The most frequent and basic physical causes of flooding are:

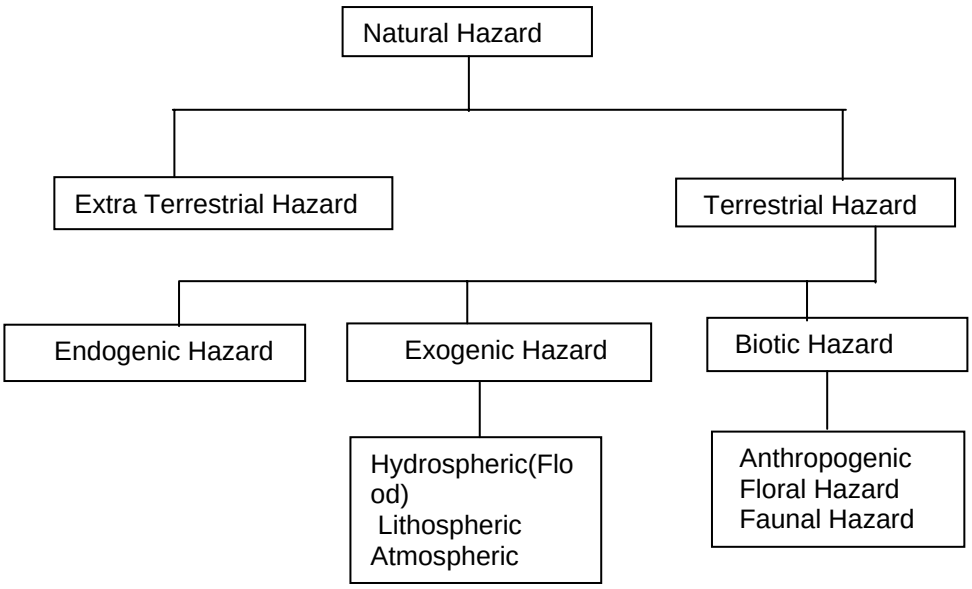
(a) Climatological causes

Climatological causes are further sub divided into:

i. *Heavy & Prolonged Rainfall* Heavy and prolonged rainfall is the most common universal cause of flooding. Stream discharges are rapidly increased by run off overtopping the natural or artificial banks. Such rainfall can vary from predictable rains over wide geographical areas (Atta-ur-Rahman, 97).

ii. Melting of Snow, Ice and Glacier In cold winter, where snowfall accumulates on the surface. Substantial flooding frequently occurs due to the melting of snow, ice and glaciers and in effect river discharge increases during summer. In the sub-continent, June, July and August are the hottest months, during which temperature often exceeds 30^{o}C, which ultimately increase melting of snow and contributing much to the discharge (Khan, 96).

Classification of Natural Hazard



(b) Partly Climatological Causes

i. Storm surges Along low laying coasts, flooding may result from excessively high tides associated with storm Surge effects.

ii. Tsunamis Some of the most spectacular disastrous coastal flooding result from tsunamis, which are waves produced by sub-marine earthquakes, landslides and volcanic eruptions.

(c) Geomorphological Causes

Geomorphological causes is further sub divided into:

i. Mass Movement Mass movement or landslide is an important geomorphic factor responsible for flood formation i.e. mud flow, debris flow, debris slide, Rock flow etc. These processes some times block river channels, damming river water, and resulting in the formation of a temporary lake. The bursting of dams cause flood in the down valleys.

ii. Breaching of Glaciers Glacier movement also causes floods. The devastating floods occur, when glacier block the river channel and forming temporary lake behind the obstruction. As the barrier burst, the entire stored water flow down stream, causing worst floods (Atta-ur-Rahman, 1997). Similarly, in 1929 floods were caused by the movement of Chony Kundan glacier across the Shyoke river in Baltistan and its subsequent bursting when over topped by water accumulated behind it, caused major disaster to down stream in the Indus plain.

5.2 Flood Intensifying Factors

The anthropogenic causes are actually intensifying factors. The construction of various structures including buildings, roads, etc on the floodplain may also unduly reduce the carrying capacity of a stream, thereby cause the ponding back of water behind the obstructions and increases flood stages further upstream.

Deforestation in the catchment area is also one of the intensifying factors. Deforestation causes an increase in run off and an associated decrease in channel capacity due to sediment deposition. It has been suggested that the felling of forest

stands and the consequent reduction in evapo-transpiration alone could significantly increase flood volume (Khan, 1993). Therefore, forests play a definite and major role in down stream flooding even where the cutting does not disturb the soil infiltration capacity. This is clear from the fact that,

a) Man has been encroaching on the floodplain by making fields, constructing houses, and shops etc. Which result in the narrowing of river channels. In flood time this narrow channel cannot accommodate such a large amount of water, eventually a heavy discharge is converted into flood.

b) Besides encroachments over low laying floodplain, man is also responsible for the digging of river channels, which increases flood intensity.

6. Causes of Floods in Pakistan

The rivers of Pakistan have a bad history of floods. Floods in the Indus basin are generally caused by natural events like heavy rainfall in the upper catchments of river and supper-imposed by snowmelt. These floods have been caused by a variety of factors. But the two most important are:

- Breaching of glaciers or landslide in the Karakoram and Himalaya
- Heavy and Torrential rainfall

Figure 2 clearly present the flood causes in Pakistan.

Flood is one of the serious and recurrent natural hazards in the study area. Both Jhelum and Neelum rivers are famous for their summer floods, usually caused by heavy monsoon rainfall and rapid melting of ice and snow, due to rise of temperature in the hottest months. In the study area, each year in July and August heavy floods occur that causes heavy damages to lives and property. They are mainly caused by excessive precipitation and snowmelt in the catchment areas of Neelum and Jhelum rivers.

Before going to discuss the climatalogical causes of flood in the study area let us have a look on the climate of Muzafferabad, discharge and drainage of Neelum & Jhelum rivers for different periods (Table. 1 & 3). Generally, the climate ranges from sub-tropical temperate to sub-alpine and alpine. Summer monsoon are common throughout the area and are followed by dry months of October and November. Snowfall starts on high elevations by about mid November and descends to forest belt by the end of December. The snowfall, which usually terminates by the end of February, some times extended upto April at the higher elevations. The thaw sets in early April and reaches its peak by the middle of May.

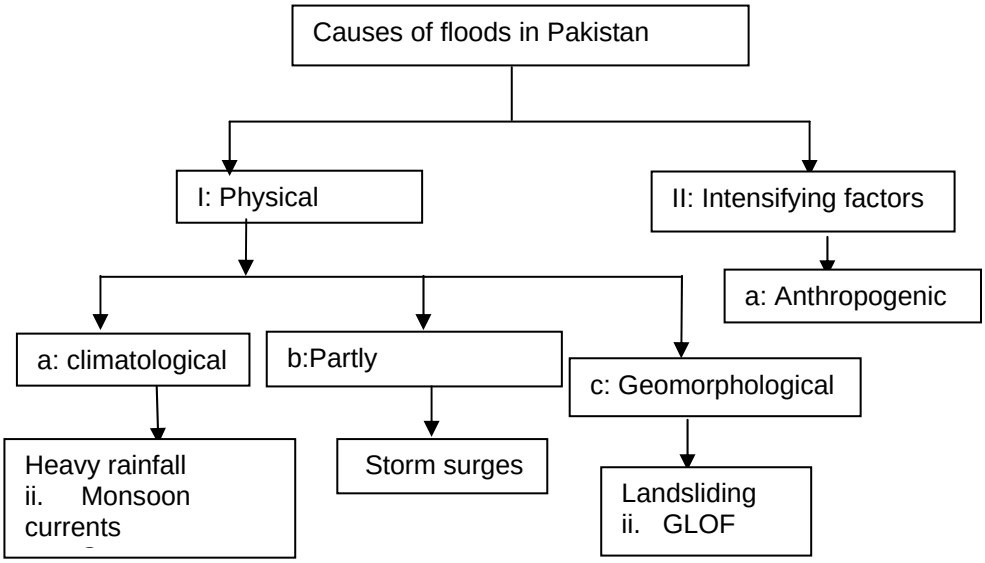
The climate varies considerably in the North and South, the Southern part of the district experiences warm summer and cold winter, whereas, in the north, summer is cool and winter extremely cold, hottest month is June and coldest month is January.

January = Mean maximum Temperature = 21^{o}C, Mean minimum Temperature = 0.6 ^{o}C.

June = Mean maximum Temperature = 43^{o}C, Mean minimum Temperature = 17 ^{o}C

The Jhelum & Neelum are the two rivers, which flow throughout the length of district Muzaffarabad. The source of Jhelum river is Verinag spring in the Anantnag (Islamabad) district of Occupied Kashmir, enters near Chakoti at the confluence of Urusa Nala & flows in Southeast to northwest direction upto Muzafferabad, where Neelum river joins it.

Figure 2 Causes of Floods in The Study Area



Then, it flows southward follow-up the border of Azad Kashmir & Pakistan. The Neelum river which was formerly known as Kishan Ganga has also its source in the occupied Kashmir and enters the Muzaffarabad district in Athmugam Tehsil and flows throughout the length of Neelum valley.

Glacier, spring and snow are the permanent source of water for these rivers. They also feed the nullahs, draining into Neelum & Jhelum rivers. The monsoon rain supplement the water in nullahs and the rivers causing high discharge during the months of July, August & September and in effect causing sever floods in these months.

It is evident from the above table that May, June as well as October and November are the dry months. Whereas, during December to March rain is received from western depression. July, August and September receive maximum precipitation, which corresponds to monsoon season. Actually rainfall is not fairly distributed throughout the year; therefore the reforestation programme has been badly affected. In winter, total number of rainy days are 22 & in summer 54, while mean annual is 85.8 days.

The detailed analysis of the collected data for the year 1992 revealed that floods in the Neelum-Jhelum rivers was caused by a heavy storm during the monsoon period. This low depression storm was originated in the Bay of Bengal and entered into the Indian-subcontinent on the 1st September, 1992. It crossed central India and reached Jodhpur by the 6th of September. It finally changed its course to North-west and entered Pakistan in the early hours of 9th September. By the end of the day, it reached Muzaffarabad. It gave 94 mm rain on the 9th September and 200mm by 10th September.

The high flood of river Jhelum is also reflected in the level of water in the Domel gauging station and Mangla dam. The table shows that on the 8th September, the discharge of river Jhelum at Domel station, Muzaffarabad was 180-m^3/s. on the 9th September; the discharge suddenly rose to 2713 m^3/s, with a fall in evening. The next day that is 10th September, the discharge rose to 3503-m^3/s. From this climax the river gradually came down to its normal flow. This is not the first time that the monsoon storm caused the floods in this part of the country. Previous to this, similar floods have been caused by monsoon storm in 1959, 1929 and 1928.

Table 1 Mean Month-Wise 60 Years Temperature & Precipitation (Muzaffarabad) (1930-90)

S. #.	*Months*	*Mean max temp (^oC)*	*Mean min temp (^oC)*	*Precipitation (cm)*
1	January	20.9	0.6	10.9
2	February	24.3	1.6	11.9
3	March	30.0	5.2	12.3
4	April	34.9	8.9	11.4
5	May	39.9	12.7	7.9
6	June	42.6	17.4	7.6
7	July	40.5	19.3	29.4
8	August.	37.4	19.6	28.7
9	September	36.2	16.4	11.5
10	October	34.3	9.9	5.8
11	November	28.8	4.2	5.4
12	December	23.2	1.5	9.8
	Annual	32.6	9.8	

Source: *Director General, Pakistan Meteorology Department, Karachi 1998.*

Table 2 Ever-Recorded Maximum Temperatures & Precipitation (Muzaffarabad) (1931-90)

S.#.	Month	Temperature (oC)	Precipitation (cm)
1.	January	27.0	25.5
2.	February	29.0	29.3
3.	March	37.0	48.1
4.	April	40.5	30.6
5.	May	46.5	24.1
6.	June	45.0	38.0
7.	July	45.0	72.1
8.	August	39.5	43.0
9.	September	39.0	32.3
10.	October	37.2	25.3
11.	November	32.2	17.6
12.	December	27.0	32.7

Source: *Director General Pakistan Meteorology Department Karachi.*

It appears that during the months of August and September, due to high temperature, a low pressure develops in the North-west Pakistan and monsoon storms have been attracted towards it. This is the principal region, where all monsoon storms end up in Jammu and Kashmir. Furthermore, floods themselves cannot be stopped. However, to reduce its effects it deems to forecast the weather data and disseminate the warning to the prone areas. In order to formulate a forecast of stream flow the techniques used are the same as those used in the field of hydrology. When forecaster receives data from different stations, and from the co-relation of rainfall and discharge, one can easily

Table 3 Month-Wise Ever Recorded Maximum Discharge of River Jhelum at Domel Station, Muzaffarabad (1976-1995)

S.No.	Month	Year	Discharge m3/s
1	January	1976	242.5
2	February	1976	415.2
3	March	1976	642.8
4	April	1991	949.7
5	May	1983	936
6	June	1987	953.5
7	July	1976	934.7
8	August	1995	895.9
9	September	1992	1102
10	October	1987	350.2
11	November	1986	169.3F
12	December	1986	268.5

Source: *Surface Water Hydrology Project, WAPDA, 1996.*

Table 4 Mean Month-Wise Flow Discharge Data for River Jhelum at Domel Station Muzaffarabd (1992)

S.No	Month	Discharge m3/s
1	January	98.27
2	February	215.3
3	March	488.3
4	April	861.5
5	May	867.3
6	June	707
7	July	548.1
8	August	536.9
9	September	1102
10	October	231.9
11	November	128
12	December	110.4

Source: *Surface Water Hydrology Project*, WAPDA, 1996

identify the floods occurrence. Consequently, the forecasted data is disseminated through tele-printer, local police stations, radio and satellite phone to warn the general public in the expected affected areas. When the people receive the warning, they will save their lives and property from the flood effects. Presently, the Geo-stationary satellites are also utilized as to forecast the weather data and in effect the flood hazard occurrence.

In order to strengthen and support the analysis, in the field survey, respondents were asked about the causes of flood hazard. Majority of the respondents were of the opinion that in the study area, floods occur due to the:

i) Melting of snow, ice and glacier
ii) Torrential rainfall as well as

Table 5 Mean Month-Wise Flow Discharge Data for River Jhelum at Domel Station Muzaffarabad (1995)

S.#.	Month	Discharge m3/s
1	January	161.6
2	February	289.3
3	March	509.1
4	April	792.1
5	May	911.1
6	June	679.3
7	July	693
8	August	895.9
9	September	313.9
10	October	141
11	November	98.35
12	December	123.8

Source: *Surface Water Hydrology Project, WAPDA, 1996.*

Table 6 Daily Flow Discharge Data for River Jhelum at Domel Station at Muzaffarabad (September 1992)

Date	*Discharge m^3/s*	*Date*	*Discharge m^3/s*
1	307.2	16	1449
2	274.7	17	1393
3	252.7	18	1360
4	233.9	19	1349
5	207.8	20	1292
6	197.5	21	1285
7	191.9	22	1210
8	180.6	23	1066
9	2713	24	950.5
10	3503	25	927.3
11	1956	26	912.5
12	1729	27	890.2
13	1662	28	837.6
14	1635	29	801.5
15	1603	30	679.2

Source: *Surface Water Hydrology Project, WAPDA, 1996.*

iii) Prolonged rainfall.

Table 7, Shows that largely respondents were aware about the flood hazard in the study area. In Makri 28% of the respondents were of the view that floods occur due to the melting of snow, ice and glacier. Whereas 58% were of the opinion that floods are caused by the torrential rainfall. While 14% favored prolonged rainfall. In Central Plate 18% of the respondents favoured melting of snow, 27% torrential rainfall, and 55% prolonged rainfall. While in Lower Plate 6% favoured melting of snow, 24% torrential

Table 7 Causes of floods as perceived from the respondents

S.#	*Sample area*	*Melting of snow %*	*Torrential Rainfall %*	*Prolonged Rainfall %*
1	Makri	28	58	14
2	Central Plate	18	27	55
3	Lower Plate	6	24	70
4	Gojra	-	-	100
5	Domel	-	-	100

Source: *Field Survey, April 2002*

rainfall & 70% prolonged rainfall. In Gojra & Domel Syedan 100% of the respondents were of the view that floods in the study area are mainly caused by prolonged rainfall.

In the study area, respondents said that floods are mostly seasonal in nature & occur in the summer months (during monsoon period, from July to September). Besides these, deforestation in the upper catchment areas is one of the major intensifying factors.

Summary and Conclusion

It was found that flood is one of the most serious Hydrospheric hazards. The main objectives of the study were to find the causes of floods. The study found that both Neelum and Jhelum rivers receive heavy floods recurrently during summer season. The analysis revealed that melting of snow as well as torrential rainfall were the major factor responsible for the causes of flood in the study area. In the months of June and July the temperature remains high, which causes heavy melting in the upstream mountains, and subsequently super-imposed by the summer monsoon. These factors collectively contribute and in effect Neelum-Jhelum river received heavy floods. Water overflowed the levees and caused heavy damages to infrastructure, human lives and other property. The analysis further confirmed that encroachment over the active floodplain and ruthless deforestation in the catchment area are major intensifying factors. The study found that due to lack of any single responsible line agency, the responsibility was spread among the different line agencies. Therefore, the flood forecasting and warning system not properly operating. Likewise, the discharge data in the hydrology department was not available at all, which further deteriorated the problem as well as in the collection and analysis of authentic data.

Detailed analysis revealed that the study area is one of the most vulnerable areas. The increasing vulnerability is not only by its location in the active floodplain, but also due to the construction of buildings and other developments in the flood prone area. As in the study area, floods are mostly seasonal in nature i.e. in the summer season. The most severe floods experienced in the study area were that of 1992 and 1958. The study found that due to the absence of Land use planning and regulation measures, the community of floodplain encouraged to built and rebuilt their dwellings in close proximity of river channel.

It can be concluded that land use planning can play a very important role in reducing the adverse effects of flood hazard. It is therefore recommended to adopt an appropriate land use planning in flood prone areas and to apply ban on further encroachment as suggested by Kates, et al, (1993), three division which are as follows:

Zone 1 (Prohibitive zone); complete ban on further encroachment.

Zone 2 (Restrictive zone): Certain activities like recreational parks and playground etc. should be allowed.

Zone 3 (warning zone).in case of emergency should be able to replace the effects and be warned by the flood situation time by time.

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